

REMARKS

Claims 1-12 are presently pending in the above-identified application. As detailed below in the "Claim Objections" discussion, Applicants have corrected the numbering of the claims herein. No new matter was added to correct such numbering.

Claim Objections

The Office Action objected to claims 5 and 6 due to their formatting. Applicants thank the Examiner for the careful reading of the claims have corrected not only the identified informalities but have also corrected the claim numbering to eliminate the "duplicate" claim 6, as per the originally filed claims. The current set of amended claims correct such informalities and Applicants request that this objection be withdrawn.

Rejection of Claims 1-6 under 35 USC § 102(b)

The Office Action rejected originally filed claims 1-6 under 35 USC § 102(b) as being anticipated by U.S. Patent No. 6,323,447 issued to Y. Kondoh et al. (hereinafter "Kondoh"). Applicants have amended certain ones of the claims herein to more particularly claim the various aspects of the invention, and respectfully submit that each of the currently pending claims is patentably distinct from Kondoh for at least the reasons set forth hereinbelow.

More particularly, the various aspects of the present invention are directed to a liquid electrical switch that uses a plurality of droplets of conducting liquid to form an electrical path. In accordance with an aspect of the invention, at least a first voltage differential is used to create a separation distance between two droplets. The droplets are illustratively contained within a housing and surrounded by an immiscible, insulating liquid. Thus, the at least a first voltage differential draws at least a portion of at least one of the droplets away from a second droplet, thus preventing electrical current from flowing from the at least one droplet to the second droplet. In accordance with a further aspect of the invention, the at least a first voltage differential is changed in a way such that at least one liquid droplet is made to come into contact with a second droplet, thus creating an electrical path between the two droplets.

Importantly, in accordance with the various aspects of invention, and as more particularly claimed in the amended independent claims herein, electrical connections are established and broken by actively changing the shape of the liquid droplets while such droplets remain stationary with respect to the rest of the device (see, e.g., Applicants' Specification, page 8, line 35 through page 9, line 5). Thus, in accordance with the invention, the shape of the liquid droplets is changed as a function of capillary action. This aspect of Applicants' invention is directed to the notion of maintaining the so-called "contact lines" amongst the liquid droplet, insulating liquid (or air) and solid phases of the electrical switch. That is, as will be understood by those skilled in the art, a contact line forms at the intersection of three phases, in particular, liquid, air and solid. The Applicants herein have realized certain advantages (as highlighted hereinbelow) are achievable by maintaining the contact lines formed by the liquid droplets, insulating liquid and solid housing surface of the liquid electrical microswitch of the present invention. Thus, in accordance with the principles of the invention, the shape of the liquid droplets is changed as a function of capillary action while such droplet remain stationary with respect to the rest of the microswitch (e.g., the droplets remain stationary with respect to the housing of such microswitch and other structural elements thereof). This can be readily examined, for example, in Figures 3 and 4 of Applicants' Specification and the accompanying description thereof.

Advantageously, mechanical wear, chemical contamination and other forms of surface degradation are substantially eliminated with switches in accordance with the principles of the present invention. Additionally, the switches described herein have no physical contact-to-contact interface in the flow path of electrical current. As described above, electrical current is always conducted through the continuous illustrative catenoid body of the liquid (liquid bridge), which is formed between the neighboring droplets during each switching cycle. This eliminates chemical and electrochemical degradation of the contacts, another important failure mechanism common in traditional, prior switches. Thus, the liquid switches of the present invention seamlessly combine exceptional reliability, with high performance, small size, and low-cost (see, e.g., Applicants' Specification, page 9, lines 5-20).

Applicants have amended the originally filed independent claims to more particularly claim the above-described aspect of the invention. For example, amended independent claims 1 recites:

“ An electrical switch comprising:
a first conducting droplet having a first voltage;
a second conducting droplet having a second voltage; and
means for reversibly contacting said first droplet with said second droplet;
said reversibly contacting said first droplet with said second droplet
occurring within a housing of said electrical switch and as a function of
capillary action; and
wherein said first conducting droplet and said second conducting droplet
remain stationary with respect to said housing of said electrical switch.”

(Emphasis added by Applicants)

Each of the currently pending independent claims has been amended in a similar fashion as the above-referenced amended claim 1 to contain similar limitations directed to the above-described features of the invention.

It is at least the above-described aspects of Applicants' invention that stand in contrast to Kondoh. That said, Applicants appreciate how the Examiner may have found certain similarities between Kondoh and Applicants' invention (as set forth in the originally filed claims) as each are generally related to electrical switches employing a liquid-to-liquid interface. However, Applicants respectfully submit that the currently pending claims, as amended herein, are patentably distinct from Kondoh, as set forth above and further discussed below.

More particularly, Applicants' understand Kondoh to teach an electrical contact breaker switch which modifies conductive fluid to place the switch in an “open” or “closed” state (see, e.g., Kondoh, column 3, lines 19-42). Significantly, however, Applicants understand Kondoh's technique, to require the use of channel pressure in the cavity and/or channel of the switch for controlling flow of the conductive fluids which ultimately define the open and closed states (see, Kondoh, column 3, lines 43-50; column 4, line 8-32; column; and Figures 2-4). As such, Kondoh's switch requires a movement

of the contact lines (i.e., the contact lines are not maintained stationary) and a confinement of the fluid (in order to allow for channel pressures to operate thereon). That is, as can be seen, for example, from Kondoh's Figures 2-4 pressure is used to force the conductive fluid into the channel(s) which, in turn, establishes the open and closed states of the switch as a function of whether the fluid is contiguous or non-contiguous (see also, for example, column 9, line 50 through column 10, line 24). As such, Kondoh's switch does not maintain stationary contact lines and does not employ any capillary action. A comparison of at least Applicants' Figure 3 and 4 with that of Kondoh's Figures 2-4 readily shows why Kondoh does not teach or suggest the aspects of Applicants invention as claimed in the amended claims herein.

Thus, Applicants respectfully submit that Kondoh's teaching stand in contrast to the present invention which, pursuant to the amended claims herein, require that electrical connections are established and broken by actively changing the shape of the liquid droplets while such droplets remain stationary with respect to the rest of the device and, as such, the shape of the liquid droplets is changed as a function of capillary action.

Rejection of Claims 9-11 under 35 USC § 103(a)

The Office Action rejected claims 9-11 under 35 USC § 103(a) as being unpatentable over Kondoh.

For at least the reasons set forth above, Applicants respectfully submit that nothing in Kondoh teaches or suggests the various aspects of Applicants' invention as set forth in the amended claims herein. In particular, Applicants submit that nothing in Kondoh teaches or suggests a liquid electrical microswitch wherein electrical connections are established and broken by actively changing the shape of the liquid droplets while such droplets remain stationary with respect to the rest of the device and, as such, the shape of the liquid droplets is changed as a function of capillary action, as required by the Applicants' amended claims herein.

Regarding the rejection of each of the presently pending dependent claims these claims depend ultimately from one of the pending amended independent claims herein which Applicants submit are patentably distinct over Kondoh, for the aforesaid reasons.

Thus, the dependent claims herein contain all the limitations of the pending amended independent claims from which they depend, and Applicants respectfully submit that these dependent claims are also patentably distinct over Kondoh for the aforesaid reasons, as well as other elements these claims add in combination to their base claim.

In view of the foregoing, Applicants respectfully submit that each of the currently pending claims, as amended, are patentably distinct from and over Kondoh, and, therefore, respectfully submit that each of the currently pending claims in the application is in condition for allowance and reconsideration is requested. Favorable action is respectfully requested.

Should the Examiner believe anything further is desirable in order to place the application in even better condition for allowance, the Examiner is invited to contact the undersigned at the telephone number listed below.

Respectfully submitted,

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